Kingdom Fungi
Characteristics of Fungi
Heterotrophic saprobes – cells of hyphae secrete digestive enzymes and absorb products of digestion
Cell wall made of chitin - a polysaccharide with added nitrogen group
Hypha - filamentous body - forming mycelial mat - each hypha is composed of a chain of cells with or without separating septa
Nuclear mitosis - all stages of mitosis go on within the nucleus - followed by nuclear division and then cell division
Some fungi have a dikaryon stage - cells of two different hyphae fuse and the nuclei of each remain distinct within the new hypha
Reproduction in Fungi

• Differ from most animals and plants in that each compartment of hypha can contain one, two or more nuclei
  – monokaryotic - each compartment has a single nucleus
  – dikaryotic - two distinct nuclei within each hyphae compartment
• Possible for many nuclei to intermingle in common cytoplasm of fungal mycelium which can lack distinct cells
  – heterokaryotic – dikaryotic or multinucleate hypha has nuclei from genetically distinct individuals
  – homokaryotic – hyphae whose nuclei are genetically similar to one another
Fungi have both asexual and sexual reproduction

Asexual -
- fragmentation (breakage) of hyphae can produce new mycelium
- production of spores by modified hyphae - spores dispersed by wind

Sexual -
always involves fusion of cells from different mating types (+/-)
in some, the cells that fuse are gametes, in others the cells that fuse are part of hyphae
in some, fusion produces a diploid zygote, in others the fusion produces a dikaryon, or heterokaryon
fusion of nuclei within dikaryon produces diploid zygote nucleus
meiosis of zygote produces haploid spores
meiosis

N
2N
N
meiosis
dikaryon
nuclear fusion
N+N 2N
meiosis
dikaryon N
Fungal Ecology

Feeding - saprobes - feed on dead or living material - secrete digestive enzymes and absorb products of digestion
some are important decomposers
can digest lignin and cellulose of wood
some are parasitic on living organisms
athlete’s foot, ringworm, corn smut, rusts
some are predatory - some can anesthetize and consume roundworms (our local oyster mushroom)
some have mutualistic relationships with other organisms
lichen = fungus + green alga
fungus provides alga with some nutrients needed for photosynthesis - alga provides complex organic nutrients to fungus
micorrhizal fungi - associate with plant roots and absorb nutrients from soil to aid plant
There are four major groups of fungi
Chytridiomycota
Zygomycota
Basidiomycota
Ascomycota
Phylum Chytridiomycota - 1000 species
aquatic, flagellated fungi

– most closely related to ancestors of all fungi
– gametes are flagellated
– has well developed sporophyte (diploid) stage
e.g. *Allomyces* - sporic meiosis with multicellular haploid stage (gametophyte) and multicellular diploid stage (sporophyte)
Phylum Zygomycota – 1050 species
Bread molds and relatives
Sexual and asexual reproduction common
Hyphae without septa, except for separation of reproductive structures
Has short diploid stage
(zygosporangium)
e.g. *Rhizopus* - zygotic meiosis - multicellular haploid stage only
Phylum Basidiomycota – 22,000 species
mushrooms, toadstools, rusts, smuts
many species eaten
many poisonous or semi-poisonous species

has well developed
dikaryotic stage

the basidiocarp (mushroom) carries basidia on gills or in pores

nuclei fuse within basidia and then produce basidiospores by meiosis
Life Cycle of a Basidiomycete

- Zygote
- Basidia
- MEIOSIS
- Formation of basidiospores
- Fusion of + and - hyphae
- Primary mycelium (monokaryotic)
- Secondary mycelium (dikaryotic)

Gills lined with basidia
Phylum Ascomycota – 45,000 species –
Most yeasts, truffles, morels
Great diversity - includes many plant parasites –
e.g. Dutch elm disease and chestnut blight
Sometimes called cup fungi because of the shape of their reproductive structures

Has well developed dikaryotic stage

The ascocarp carries asci within cups

Nuclear fusion occurs within ascus, meiosis follows producing ascospores

Some species lack a sexual stage (e.g. *Penicillium*)
Ascomycetes

Morel

Cup fungus
Life Cycle of an Ascomycete

Ascospore

Asexual reproduction by spores (conidia)

Trichogyne

Each haploid nucleus divides once by mitosis

Strain

Ascogonium

Antheridium

Plasmogamy (cytoplasmic bridge allows strain nuclei to pass into ascogonium)

Monokaryotic

n

MEIOSIS

Young ascus

Zygote

Karyogamy (formation of young ascus)

2n

Dikaryotic

Fully developed ascocarp composed of dikaryotic (ascogenic) hyphae and sterile hyphae
• Yeasts
  – unicellular - most reproduction is asexual and takes place by cell fission or budding
    • ferment carbohydrates - produce ethanol as byproduct
    • play a leading role in genetic research
Ecology of Fungi

- Fungi are saprobes - heterotrophs that secrete digestive enzymes and absorb products of digestion.
- Some are important decomposers can digest lignin and cellulose of wood
- Some are parasitic on living organisms athlete’s foot, ringworm, corn smut, rusts
• some are predatory - some can anesthetize and consume roundworms (our local oyster mushroom)

• some have mutualistic relationships with other organisms
  lichen = fungus + green alga
  fungus provides alga with some nutrients needed for photosynthesis - alga provides complex organic nutrients to fungus
  micorrhizal fungi - associate with plant roots and absorb nutrients from soil to aid plant
Fungus is usually ascomycete. Specialized hyphae penetrate photosynthetic cells and transfer nutrients. Lichens are able to invade harsh terrains and climates. They are extremely sensitive to pollutants.
About 90% of all kinds of vascular plants are involved in mutualistic symbiotic relationships (mycorrhizae). Fungi are able to extract raw nutrients from soil that plants can’t.

- **Arbuscular mycorrhizae** - fungal hyphae penetrate outer cells of plant root.
- **Ectomycorrhizae** - hyphae surround, but do not penetrate, cell walls of roots.

![Diagram of root cells of plants (cross-section)]
Ectomycorrhizae on Pine Roots
• A range of mutualistic fungal-animal symbioses has been identified.
  • ruminants
  • leaf-cutter ants
  • termites
Chytridiomycosis - emergent infectious disease in amphibians
chytrid *Batrachochytrium dendrobatidis*

Aflatoxins - carcinogenic compounds produced by strains of *Aspergillus flavus*
grows on corn, peanuts, cotton seeds